SUBSTITUTE SPECIFICATION

ELECTRIC POWER DEMAND PREDICTION METHOD AND SYSTEM THEREFOR

BACKGROUND OF THE INVENTION

[0001] The present invention relates to an electric power demand prediction method and a system for providing a prediction of an electric power demand to be satisfied under a contract with an electric power supplier or an electric power company.

[0002] Conventionally, prediction of electric power demand is carried out by predicting a total demand per individual electric power company for controlling the power supply by determining the requirements of power plants bearing a basic and constant power load and power plants providing variable outputs depending upon variation of the power load. Thus, electric power demand prediction has been performed by each individual electric power company independently of the others. Furthermore, the prediction is per facility serviced by the electric power company. However, in the environment where energy consumers may freely select electric power suppliers and/or electric power companies for receiving service, the conventional manner of prediction and electric power supply control cannot be always adapted to electric power conditions.

[0003] Conventionally, there is no business entity

performing electric power supply services. Therefore, it has been merely the task of each electric power company to predict electric power demand in each territory for performing electric power supplycontrol. For instance, prediction has been performed for electric power demand for the next day or week or a predetermined period on the basis of a weather report, the day of the week or a past record value in the same season, for effecting the necessary electric power supply control. A technique relating to electric power demand prediction has been disclosed in Japanese Patent Application Laid-Open No. Heisei 11-346438. The above-identified publication discloses a method for automatically predicting the demand for electric power in a central load dispatching and liaison office. The publication also discusses a prediction method which is generally applicable for various prediction models, such as a feedback type network, neural network and so forth.

[0004] The techniques disclosed in the above-identified publication are not directed to electric power demand prediction and control related to liberalization of the power supply. This is not satisfactory in the liberalized environment of a power supply. Particularly, under the liberalized environment, electric power supply satisfactory both for the energy consumers and electric power supplier or electric power company cannot be realized unless more precise and more

careful prediction and control are performed. Especially, when a business entity of an electric power supply service supplies power under contract with various energy consumers, proper electric power demand prediction becomes an important task.

[0005] On the other hand, it becomes necessary to obtain an estimated value or predicted value of electric power demand per customer group per facility of the electric power system on the basis of contracts with electric power suppliers, namely, a so-called retail business of electric power organized according to liberalization of the power supply. Furthermore, if estimation and the prediction for power of demand is performed per retail seller of electric power, only information concerning energy consumers who engage in a contract with a retail seller is available, which tends to restrict improvement of the precision of an estimated value or predicted value.

SUMMARY OF THE INVENTION

[0006] It is therefore an object of the present invention to provide an electric power demand prediction service method and a system therefor, which may derive an estimated value and/or predicted value of electric power demand of an arbitrary customer group and provide the derived information to electric power suppliers (which generally refers to those supplying electric power,

including retail sellers of electric power, electric power companies and so forth).

[0007] According to a first aspect of the present invention, an electric power demand prediction service method in connection with the supplying of electric power from an electric power supplier to an energy consumer, comprises the steps of: connecting a power supplier for supplying electric power to an energy consumer through a communication circuit; receiving an electric power demand and supply record data which is measured and collected by the electric power supplier; performing a prediction calculation of the demand for power to be supplied from the electric power supplier on the basis of the received record data; delivering the power demand prediction data to the electric power supplier; calculating a charge for the service producing the prediction data to the electric power supplier; and delivering a result of the charge calculation process to the electric power supplier.

[0008] According to another aspect of the present invention, an electric power demand prediction service system in connection with the supplying of electric power from an electric power supplier to an energy consumer, comprises: a demand prediction service center including: electric power demand and supply record data receiving portion connected with a power supplier for supplying electric power to the energy consumer through a

communication circuit, and receiving an electric power demand and supply record data which is measured and collected by the electric power supplier; a predicting portion performing prediction calculation of the demand power to be supplied from the electric power supplier on the basis of the received record data; a delivering portion for delivering the power demand prediction data to the electric power supplier; a charge calculation processing portion for calculating a charge for the service producing the prediction data to the electric power supplier; and a delivering portion for delivering a result of a charge calculation process to the electric power supplier, for providing the prediction data of the demanded power to the electric power supplier.

[0009] In the preferred construction, the demand prediction service center may perform prediction of the demanded power using demanded power prediction data held by the electric power supplier or the database of an external organization in addition to the power demand and supply record data. The demand prediction service center may cumulatively store demanded prediction data for the electric power supplier in a customer data file and make reference to the customer data f ile upon demand prediction. The demand prediction service center may be a predicting portion which performs prediction of demanded power on the basis of reception of a load survey data or

distribution line measurement data of the electric power supplier or a result of cluster analysis of a load curve record value. The charge processing portion to the electric power supplier in the demand prediction service center may be a charge processing portion determining a charge to a customer on the basis of at least one of precision of prediction, size of geographic area, length of prediction period, time interval of prediction per se, and size of electric power variation amount in the load curve in a prediction time zone.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The present invention will be understood more fully from the detailed description given hereinafter and from the accompanying drawings of the pref erred embodiment of the present invention, which, however, should not be taken to be limitative to the invention, but are provided only for explanation and understanding of the principles of the invention.

[0011] In the drawings:

[0012] Fig. 1 is a block diagram showing the overall construction of a prediction service system according to the present invention, which includes a demand prediction service center;

[0013] Fig. 2 is a block diagram showing the construction of a demand prediction service center according to the present invention;

[0014] Fig. 3 is a block diagram showing one example of the structure of a database on the customer side;

[0015] Fig. 4 is a table illustrating predicted data obtained per kind of contract;

[0016] Fig. 5 is a flowchart showing a general flow of the demand prediction process carried out in the prediction service center;

[0017] Fig. 6A is a table and Fig. 6B is a diagram illustrating a demand predicting method;

[0018] Figs. 7A and 7B are time diagrams showing one example of the result of demand prediction;

[0019] Fig. 8 is a general diagram illustrating a data file of a customer (electric power supplying business entity) held by the prediction service center;

[0020] Fig. 9 is a flowchart showing one example of an accounting process; and

[0021] Fig. 10 is a table showing an accounting objective prediction condition for a predetermined period per electric power supplying business entity.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022] The present invention will be described hereinafter in detail in terms of a preferred embodiment of the present invention with reference to the accompanying drawings. In the following description, numerous specific

details are set forth in order to provide a thorough understanding of the present invention. It will be obvious, however, to those skilled in the art that the present invention may be practiced without these specific details. On other hand, well-known structures are not shown in detail in order to avoid unnecessary obscurity of the present invention.

[0023] Fig. 1 is a block diagram showing the overall construction of a demand prediction service system according to the present invention. The reference numeral 10 denotes an electric power demand prediction service center (which may also be referred to as an electric power demand prediction business entity). The construction of the electric power demand prediction service center will be discussed later. The electric power supply business entities include those identified by PSa to PSn. DBa to DBn identify databases respectively held by the electric power supply business entities PSa to PSn, in which data necessary for demand prediction is stored. Thus, among data stored in each database, necessary data for predicting electric power demand is provided to the demand prediction service center 10. Among data stored in the database, there is prediction data predicted by the electric power supply business entity independently. Then, such prediction data is conf igured to be used by the service center as basic data.

[0024] PSn (n = a to n) identifies the electric power supply business entity, including electric power companies, retail sellers of electric power, such as electric power service business entities, which have a contract with the electric power company or, other electric power supply business entity. Irrespective of the scale of the business entities, the electric power supply business entity, controlling the supply of power depending upon predicted demand of the electric power, is a target of the service. The reference numeral 16 denotes energy consumers (L). To the electric power supply business entity PSa, an energy consumer group 16a is connected for receiving electric power in accordance with a given contract. The reference numeral 16b denotes an energy consumer group receiving electric power from the electric power supply business entity PSb. Similarly, the reference numeral 16n denotes an energy consumer group receiving service of electric power from the electric power supply business entity PSn. The reference numeral 18 ,denotes a communication circuit, such as the internet, to be used for sending a request for electric power demand prediction, providing data, providing the result of a prediction, delivery of a bill for charges, other demands and so forth between the electric power supplier and the electric power demand prediction service center 10. For example, in the case of entity PSa, 20a represents a transmission channel

for delivery of prediction result data to the entity PSa and 20b represents a transmission channel for sending data and a request for prediction of demand and other requests from the entity PSa to the service center 10. Similarly, signal lines 20b to 20n and 22b to 22n are provided on channels to be used for communication between respectively corresponding electric power suppliers and the service center 10.

[0025] The reference numeral 14 denotes a database of an external organization to be accessed when data of the external organization is used as auxiliary data. In this case, databases of the external organizations are identified by DBel to DBej. The database of an external organization may include a database of a public agency and so forth. Data to be obtained from the database of the external organization may relate to weather or an electric power demand record of a local area or the whole country for a past period of time and so forth. The reference numeral 24 denotes a communication circuit, such as the internet, similar to the communication circuit 18 and is to be used for obtaining data from an external organization, as required. It should be appreciated that use of the database of the external organization is not essential for a certain prediction service center of a certain function.

[0026] Fig. 2 shows the construction of a demand prediction service center 10, which is constructed with a

microcomputer and so forth. The reference numeral 38 denotes a customer information authentication and management portion, which receives signals 22a to 22n from the customer (in this case, electric power supplier), performs authentication by checking whether the customer is an authorized customer under contract, determines the contract condition and so forth, on the basis of a password or the like input by the customer, and performs management processing using a customer information management file 42 by updating customer data in preparation for the next request for prediction.

[0027] The reference numeral 34 denotes an accounting portion for performing a charge calculation for the prediction service. The accounting portion performs charge calculation using data in a charge data file 46 depending upon the requesting condition of prediction within a given period. The reference numeral 32 denotes an external data managing portion which is active when data provided by the customer is not sufficient for satisfying a condition for performing a prediction requested by the customer and when judgment is made that data from the external organization may satisfy the requested precision of the demand prediction. The external data managing portion 32 will then access the external database, such as the data base of a public agency (or private organization) to obtain necessary information. The external data

managing portion 32 also the accessing of data and stores the obtained data in an external data file for re-use in the future.

[0028] Accordingly, when corresponding data is not stored in the file 44, data is newly obtained from the external organization. For example, in Fig. 2, if data is lacking in the data file 48 from the customer, the accumulated data file 44 of the external data is assessed for newly obtaining the necessary data. If data is still lacking after accessing the accumulated data file 44, the database of the external organization is accessed for newly obtaining the necessary data. In such a case, use of the accumulated data file and access to the database of the external organization and so forth are taken into account in the accounting process. In general, use of the accumulated data file and access to the database of the external organization and so forth will become necessary in the absence of relatively new data or when data at a different viewpoint is desired for a predicting operation. The reference numeral 40 denotes a predicting operation processing portion for performing the actual predicting operation using data obtained as set forth above. The predicting operation processing portion 40 includes various prediction libraries, such as a numerical value processing library, a clustering analysis library, a domestic power consumption model analysis library and so forth, which may

significantly influence the quality of the prediction data of the demand prediction service center 10. The reference numeral 50 denotes a display device provided in the service center 10 for displaying the result of prediction or the process of a predicting operations. The display device 50 is used for checking information before transmitting prediction data to the electric power supplier and for other purposes.

[0029] Fig. 3 is a block diagram showing one example of a construction on the side of the electric power supplier. Fig. 3 shows an example of a PSa. It should be noted that the construction for each individual electric power supplier is not necessarily the same as that of the PSa as illustrated. Each electric power supplier will often have its own database. As shown in Fig. 3, a value representing an amount of electric power is provided by the device 52 of the end customer (energy consumer) and is transmitted to the database of the electric power supplier through a communication circuit 54. On the other hand, the ref erence numeral 60 denotes a distribution transformer feeder transmission measuring device connected to the power supplier side through a communication circuit 62 for inputting a measured value. On the power supplier side, the measured value is cumulatively stored in the database (e.g. DBa) of the power supplier through the communication processing portion 56.

[0030] The reference numeral 58 denotes a customer demand cluster analyzing portion, which receives an input signal, such as a load curve record value measured by the customer or the general information of the customer, to perform an analysis. A signal 67 indicative of the result of analysis is input and stored in the database 12 (DBa). Thus, the data base on the side of the power supplier not only holds the measured data per se as a data base, but also stores the result of analysis on the side of the customer. On the other hand, for the customer having no measuring device, a result estimated from general information is stored in the database. As set forth above, the database DBa, for example, is unique for the customer. A predicting operation is performed in the prediction service center by effectively using data stored, as set forth above, for further precise prediction. Data necessary for prediction from the data of the database DBa is fed to the demand prediction service center 10 shown in Fig. 1 to receive the predicted result, thereby to perform power generation control.

[0031] Fig. 4 shows an example of a demand prediction contract between the demand prediction service center 10 and the power supplier. In the demand prediction service center 10, a demand prediction service is performed depending upon the content of the contract with the power supplier. Here, there is shown an example where there are

various kinds of contracts A to S. For example, a contract A includes data provided from the power supply business entity, which represents the presence of analysis data of the power supplier itself, including the measured data. A contract C represents a case where no data can be provided, and so data of the external organization has to be relied on. In Fig. 4, the item next to the contract item is the item indicative of whether the external database has to be used for satisfying a demand of the demand prediction or not. In the contract A, the database of the external organization is used under contract. Namely, the second item indicates whether the database of the external organization is to be used, when the data provided by the electric power supplier or the electric power supply business entity is lacking, for satisfying the prediction demand. The contract B does not use the data of the external organization and performs prediction based on the data provided from the electric power supplier, the data held by the prediction service center, know how of prediction, tools of prediction and so forth.

[0032] The items next to the second item represent the prediction period. Namely, the item in question indicates whether the demand period is only long term or short term. In the illustrated example, the contract A is for only short period prediction. On the other hand, the contract B represents an example in which the requested

prediction is only a long term prediction. The items next to the prediction period items concern the predicting region. This item indicates whether the prediction has to be made for a designated area, the entire area or for a particular energy consumer, among energy consumers being supplied with electric power from the electric power supplier. Under the contract A, in addition to a prediction for the particular area, demand prediction information for the overall area has to be supplied to the electric power supplier. On the other hand, the contract S has a content requiring prediction for all items, namely for all of the particularly designated areas, the overall area and a particular energy consumer. This is an example of only a basic contract, and the customer (electric power supplier) may receive prediction service beyond the content of this basic contract. In such a case, a charge will be considered in the accounting.

[0033] Fig. 5 is a process flowchart of the processing in the service center 10 in the case where a predicting operation is performed according to a request for a prediction. At step S12 (e.g. on line 20a) , authentication is performed to determine whether the power supplier requesting a prediction is authorized under contract or not by checking the password or the like. Also, at step S12, the content of the contract is also checked for the electric power supplier for which

authentication is successful. Next, at step S14, the condition of demand prediction is checked. For example, a check is performed for the period of the prediction under contract, the required precision, the necessary data for the required precision and so forth as the condition for prediction. Then, at step S16, a check is performed to determine whether data is sufficient for making a prediction satisfying the demand of the power supplier. If the conditions set forth above are satisfied, the predicting operation is performed by selecting a prediction method among a plurality of prediction methods or selection of a prediction method is performed at step S18. Namely, in the selection at step S18, whether the required precision of prediction can be achieved by only correction of the existing prediction pattern, by complicated converging calculation or so forth adapting to demand of the customer is determined. Then, at step 20, a particular predicting operation is performed.

[0034] Fig. 6A shows an example of the prediction method. For example, (1) when the customer (here, the power supplier is referred to) monitors the power supply amount, a prediction is performed using on-line data resulting from monitoring; (2) when the customer monitors the power supply amount, a prediction is performed using the result of clustering analysis made by the customer and general information; (3) is a case where prediction is

performed using a past record; (4) is a case where prediction of total demand is performed on the basis of load prediction value per group; and (5) is a case of prediction per particular period, which is the case where a prediction is performed with respect to the period R, as shown in Fig. 6B. The predicting method will be selected according to respective cases.

[0035] At step S22, evaluation and correction is effected for the result of a predicting operation. For example, in evaluation and correction, a check is performed to determine whether the predicted pattern is not significantly differentiated from the past predicted pattern or whether the predicted pattern is quite similar to the past predicted pattern. Evaluation and correction may be carried out with display of the predicted pattern on a display device at the display step S24. At step S26, the result of prediction is transmitted to the customer (electric power supplier). At step S28, the result of prediction is held as a database for use in the next predicting operation.

[0036] On the other hand, if a judgment is made that data is lacking for the predicting operation, which is checked at step S16, the missing data is obtained from the customer (power supplier) at step S30. On the other hand, at step S32, a judgment is made to determine whether data taken from the external organization can be used for

prediction or not. If the data obtained from the external organization can be used, a check is performed to determine whether all data necessary for a predicting operation has been obtained at step S36. If a judgment is made that all necessary data has been collected, a predicting operation is performed at step S18 and subsequent steps. Correction for precision or so forth to be performed at step S38 is effected when the demanded precision of the prediction data cannot be obtained by data obtained from the external database. In such a case, a predicting operation is executed with correction of the precision to the level to be achieved by the given data or correction of the prediction period. At step S32, when judgment is made that the already obtained external data is not usef ul, data is again obtained f rom the external database. Of course, such an effort should be taken into account during the accounting process.

[0037] Figs. 7A and 7B show a particular example of the result of a predicting operation. Fig. 7A shows the result of prediction per week, as well as an average demanded power amount predicted per week and per days of the week. On the other hand, Fig. 7 (B) shows a result of prediction (Pl) effected per hour of the day (twenty-four hours) and also shows an average demand power amount (P2) at four hours intervals. Portion (a) in Fig. 7(B) shows the average power amount at four hour and portion (b) shows

the predicted value of the average demand power amount at one hour intervals.

[0038] Fig. 8 shows an example of a graph of the customer data file data. The lateral axis represents a time axis in general and including the hour, the week and so forth. In Fig. 8, portion (a) illustrates the past power demand pattern per electric power supplier and is a demand prediction pattern per week, as shown in Fig. 7A, or a demand prediction for a day (twenty-four hours) or other various load demand model patterns. Such a load demand model pattern is stored so as to be made reference to upon subsequent demand prediction for improving the precision of a demand prediction, thereby shortening the operation period of the demand prediction. Portion (b) of Fig. 8 shows a model representing a common demand pattern in the power suppliers PSa to PSn to be used for any of power suppliers. By making reference to such data, precise prediction can be done quickly. In the case where it is desired to perform pattern correction with a different viewpoint, or when a power demand pattern of the power supplier is to be predicted, the models of the patterns are stored for use.

[0039] Fig. 9 is a flowchart illustrating a charging operation. At step S42, the case of a predicting operation in the predetermined period of the customer is picked up. For example, as shown in Fig. 10, a predicted

information providing condition for a predetermined period per the power supplier is derived. Then, on the basis of such record, an accounting process for the predetermined period is performed.

[0040] At step S44, a judgment is made as to whether the picked-up case of a predicting operation for the customer falls within the range of the contract or not. If the picked up case of the prediction operation falls within the range of the contract, a charge calculation is performed according to the contract at step S46. However, for some customers, all of the cases of a prediction operation may not fall within the range of the relevant contract. If some cases of a prediction operation fall outside of the contract, the total charge to be billed to the customer may be derived while taking an extra service into account at step S60, at which the total charge is displayed per customer and the charge file is updated. On the other hand, some customer may have a contract for a fixed charge to be billed at step S46.

[0041] If judgment is made that some prediction operation does not fall within the contract as determined at step S44, a check is performed to determine whether data is obtained from an external database out of the contract at step S48. At step S50, a check is made to determine what modification has been made with respect to the content of the contract. For example, when the area to perform the

prediction operation is modified with respect to the initially set area, a check is made at step S52. When the area is modified by expanding or contracting the area as determined at step S52, such modification of the area is reflected in the charge calculation at step S58. On the other hand, at step S54, it is also checked to determine whether the kind of business to perform the prediction operation is changed or not. If the kind of business is changed, this fact is reflected upon the charge calculation at step S58. Change of the kind of business means that the power demand prediction of the manufacturing industry is initially requested, and, subsequently, a demand prediction including complex housing is requested, or, subsequently, a request is changed to prediction of the complex housing, for example. At step S56, a check is performed to determine whether the prediction period has been changed or not. For example, modification from a short period to a long period or a change of season for a short period and any change of frequency of the initial prediction may be checked at step S56. Then, any change of the prediction frequency is reflected in the charge calculation.

[0042] As set forth, at step S60, for some customer, part of the service may fall outside of the contract. In such a case, the total charge to be billed is calculated to include the charge for the service within the contract and the extra charge for the service outside of

the contract. At step S62, a check is performed to determine whether the charge calculation is completed for all customers.

[0043] It is possible that some of the customers form a group so as to be a single customer. Also, the customer can be a power supply service business entity. All of such customers may be simply dealt with as a customer. If special treatment is required, necessary special treatment will be handled in the content of the contract to reflect such special treatment in calculation of the charge. Also, when a database of the external organization is used, such a charge portion may be pointed out to the customer.

[0044] Also, in the charge calculation process, consideration will be given to made for the case where a charge depends upon the precision level of the prediction, namely a higher precision will result in a higher charge, or where prediction can be made simply by modification of the prediction data provided by the power supplier. Also, when the load prediction pattern is similar to that of other power suppliers, it is possible to perform a correcting prediction based thereon. By making reference to the prediction pattern of a plurality of power suppliers, prediction data with a higher precision may be provided.

[0045] As set forth above, in accordance with the

present invention, since the electric power supplier may preliminarily engage with the demand prediction service center under contract and provide data necessary for prediction, appropriate prediction data can be obtained for efficiently determining control demand and supply. On the other hand, since the demand prediction service center has a system to charge the electric power supplier through a charge calculation process depending upon provided prediction data, substantial effect can be achieved in billing.

[0046] Although the present invention has been illustrated and described with respect to an exemplary embodiment thereof, it should be understood by those skilled in the art that the foregoing and various other changes, omissions and additions may be made therein and thereto, without departing from the spirit and scope of the present invention. Therefore, the present invention should not be understood as limited to the specific embodiment set out above, but is intended to include all possible embodiments which can be embodied within a scope encompassed and equivalent thereof with respect to the features set out in the appended claims.